On the Title of Moriarty's *Dynamics of an Asteroid*

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We propose an explanation of the title of Prof. James Moriarty's treatise *Dynamics of an Asteroid*, a scientific work mentioned by Sherlock Holmes in *The Valley of Fear* and prominently featured in Guy Ritchie's 2011 film *Sherlock Holmes: A Game of Shadows*. Our views on the subject differ from those expressed in Isaac Asimov's "The Ultimate Crime".

Isaac Asimov[1] and others[2] have remarked on the peculiarity of the title of Prof. James Moriarty's *Dynamics of an Asteroid*, a scientific treatise that, in the words of Sherlock Holmes, "ascends to such rarefied heights of pure mathematics that it is said that there was no man in the scientific press capable of criticizing it." In particular, why is *asteroid* in the singular? Asimov had his own ideas about this, but I think that there might be a more plausible solution to this puzzle.

In Victorian Britain there were several books called *Dynamics of a Particle*. For example, Peter Guthrie Tait and William J. Steele collaborated on a textbook of that name, intended for Cambridge undergraduates. That work appeared in 1856 and went through seven editions, the last from 1900.[3] There is also a *Dynamics of a Particle* by Edward Routh, published in 1898.[4] A search of the Harvard library catalogue returns several subsequent publications with similar titles, by R. J. A. Barnard,[5], S. L. Loney,[6], and W. D. MacMillan.[7] Why was *particle* used there as a singular noun?

In the scientific parlance of the time, "particle" meant something rather different from the sense modernly attached to the word by quantum physics: it referred to a solid body of fixed mass, whose physical state at a given time may be entirely characterized by one position and one velocity. In particular, the actual size and shape of the body are irrelevant, so that no rotation or any other internal motion or property need be taken into consideration. A synonym for particle in this sense is "material point".[8]

By considering the motion of a single particle, the student avoids the complications introduced by the changing interactions between particles as they move relative to one another. Thus, in Moriarty's day, "dynamics of a particle" was a standard first course in mathematical physics, which covered essentially the same material as a modern introductory course in Newtonian mechanics like the one that most university students in the natural sciences are required to complete today. In the Victorian physics curriculum, this would have been followed by more advanced studies on the dynamics of systems of particles, of rigid bodies, of deformable solids, and of fluids.

Gauss and other 19th-century mathematical scientists who worked on the subject treated an asteroid as a particle, subject only the gravitational attraction of the sun and to small perturbations from the influence of nearby planets. In this context, the title *Dynamics of an Asteroid* suggests to me that Moriarty's approach was general and theoretical, closer to pure mathematics than to observational astronomy. This is the opposite of Asimov's interpretation, who concluded that Moriarty must have had a particular asteroid in mind. It is, on the other hand, a view strongly supported by the fact that Moriarty's other known publication was his youthful paper on the binomial theorem, a strictly mathematical subject.[9]

Mathematics in 19th-century British universities was still very much under Newton's influence, so that dynamics of a particle (such as an asteroid) would have been a subject of interest to mathematicians just as much as to physicists. Lewis Carroll, creator of *Alice in Wonderland* and —as Charles L. Dodgson— mathematical lecturer at Oxford, published in 1865 a satirical pamphlet called "The Dynamics of a Parti-cle" [*sic*], which dealt facetiously with certain issues of the Oxford politics of the day, especially William Gladstone's defeat in his bid for reelection as Member of Parliament for the university.[10] Carroll's title is evidently a play between the name of an introductory course in mathematical physics, with which Dodgson and his colleagues would have been very familiar, and the political sense of the world "party".

Moriarty might have named his treatise on celestial mechanics by analogy to an introductory physics text in order to encourage students to read it. In this he must have failed, given what we know of the work's mathematical abstruseness. It is not uncommon for great theoretical scientists to underestimate the mathematical difficulties that their work will pose for common readers. For instance, Sir Roger Penrose's *Road to Reality*, published in 2004, is intended for a lay audience but includes discussions of hypercomplex numbers, symplectic manifolds, Riemann surfaces, and gauge connections, among many other topics in higher mathematics.[11]

Asimov argued that the mere study of the motion of a generic asteroid, treated as a particle, would have been a well worn subject by 1875 (around which time he estimated that Moriarty's work was written), and therefore would have afforded little scope for the author's genius. But we must not forget that Cauchy's work on complex-valued functions, a deathless *tour de force* of pure mathematics, grew out of the study of Kepler's equation for the elliptical orbit of a planet going around the sun. That very same problem had already inspired Newton to invent topology, an entirely new branch of mathematics,

A TREATISE

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WITH NUMEROUS EXAMPLES.

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SECOND EDITION.

Cambridge and London:
MACMILLAN AND CO.
1865.

FIG. 1: Title page of the second edition of *Dynamics of a Particle* by Tait and Steele.

but that work was so far ahead of its time that his colleagues ignored it and it lay forgotten for 300 years.[12] I suspect that Moriarty's study of the motion of an asteroid might have similarly motivated him to develop original mathematical concepts, which unfortunately were not understood at the time and were later lost, probably because they were suppressed after the author's criminal career became widely known.

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[1] I. Asimov, "The Ultimate Crime", in *More Tales of the Black Widowers*, (Garden City, NY: Doubleday, 1976), pp. 166–80.

[2] B. E. Schaefer, "Sherlock Holmes and Some Astronomical Connections", J. Br. Astron. Assoc. **103**, 30–4 (1993).

[3] P. G. Tait and W. J. Steele, *A Treatise on Dynamics of a Particle with Numerous Examples*, 7th ed., (London and New York: Macmillan, 1900).

[4] E. J. Routh, *A Treatise on Dynamics of a Particle with Numerous Examples*, (Cambridge, UK: Cambridge University Press, 1898).

[5] R. J. A. Barnard, *Elementary dynamics of the particle & rigid body*, (London: Macmillan, 1916).

[6] S. L. Loney, *An elementary treatise on the dynamics of a particle and of rigid bodies*, (Cambridge, UK: Cambridge University Press, 1919).

[7] W. D. MacMillan *Statics and Dynamics of a Particle*, (New York: McGraw-Hill, 1927).

[8] L. D. Landau and E. M. Lifshitz, *Mechanics*, 3rd ed., (Oxford, UK: Elsevier, 1976), pp. 1–2.

[9] P. Anderson, "A Treatise on the Binomial Theorem", Baker Street J. **5**, 13–8 (1955). Reprinted in *Sherlock Holmes by Gas-Lamp*, edited by P. A. Shreffler, (New York: Fordham University Press, 1989), pp. 274–9.

[10] L. Carroll, "The Dynamics of a Parti-cle", in *The Lewis Carroll Picture Book*, edited by S. D. Collingwood, (London: T. Fisher Unwin, 1899), pp. 58–75. The original pamphlet appeared in 1865.

[11] R. Penrose, *The Road to Reality: A Complete Guide to the Laws of the Universe*, (London: Jonathan Cape, 2004).

[12] V. I. Arnol'd, *Huygens and Barrow, Newton and Hooke*, (Basel: Birkhäuser, 1990), ch. 5.